as described in the California MUTCD. Reflective delineation devices used on guardrail installations should be aimed to provide optimum visibility. Guardrail located more than 12 feet from the roadbed should not have reflective delineation devices installed. Guardrail intruding on the roadbed, such as at approaches to narrow bridges, warrants additional delineation treatment as described in the California MUTCD.

Weathering steel or ungalvanized steel is allowed only under the conditions stated in TOPD 02-02 for new installations or upgrading of guardrail or median barrier on state highways. TOPD 02-02 can be found on the Office of Traffic Safety Program's "Approved Devices and Products" web site.

Thrie Beam Barrier should be used as guardrail only in special situations where additional height of rail is required. The rail elements are 50 percent heavier than metal beam guardrail. It uses a nominal 20-inch wide x 3½-inch deep, three-ribbed, galvanized metal beam with the top of the beam generally 32 inches above the surface beneath the rail. Other installation details are similar to those for metal beam guardrail.

Section 7-04 -- Median Barrier

7-04.1 Purpose

Ideally, median barriers should:

1. Reduce the risk of an out-of-control vehicle crossing the median and colliding with opposing traffic.
2. Reduce the risk of deflection back into the traffic stream of a vehicle colliding with the barrier.
3. Decelerate the errant vehicle within tolerable limits.

While median barriers are capable of preventing nearly all of the cross-median accidents, their installation will result in fixed-object accidents that might not otherwise occur.

7-04.2 Barrier Types

The approved standard types of median barriers for new installation are: (1) concrete median barrier, and (2) thrie beam barrier (single or double). Headquarters approval is required for any new installation or reinstallation of metal beam barrier or cable barrier.

7-04.3 Study Warrants

1. *Freeways*. The median barrier study warrants shown in Figure 7-7 have been developed through extensive study of freeway cross-median accidents. The need for a barrier should be considered on freeways whenever these study warrants are met. Any decision to install or not to install a barrier where study warrants are met should be thoroughly documented.

When the AADT is less than 20,000, the probability of an out-of-control vehicle crossing the median and colliding with an opposing vehicle is low. When the median width is more than 75 feet the probability of an out-of-control vehicle reaching the opposing lanes is low. Barriers in these cases should be considered only if there is an unusually high number or rate of cross-median accidents involving opposing vehicles. A cross-median accident is strictly defined as one in which an out-of-control vehicle crosses the median of a 4 or more lane road and strikes, or is struck by, a vehicle from the opposite direction.

With any AADT or median width, barriers should be considered if there has been a high rate of out-of-control cross-median accidents involving opposing vehicles. A rate based on at least three accidents in 5 years, of 0.5 cross-median accidents per mile per year of any

severity, or 0.12 fatal cross-median accidents per mile per year involving opposing vehicles justifies analysis to determine the advisability of a barrier. Where less than 5 years of accident data exists and the rate criteria is met, further analysis should be conducted to determine the advisability of a barrier.

Median barriers should be provided on new construction whenever it is anticipated that they will be justified within five years after construction.

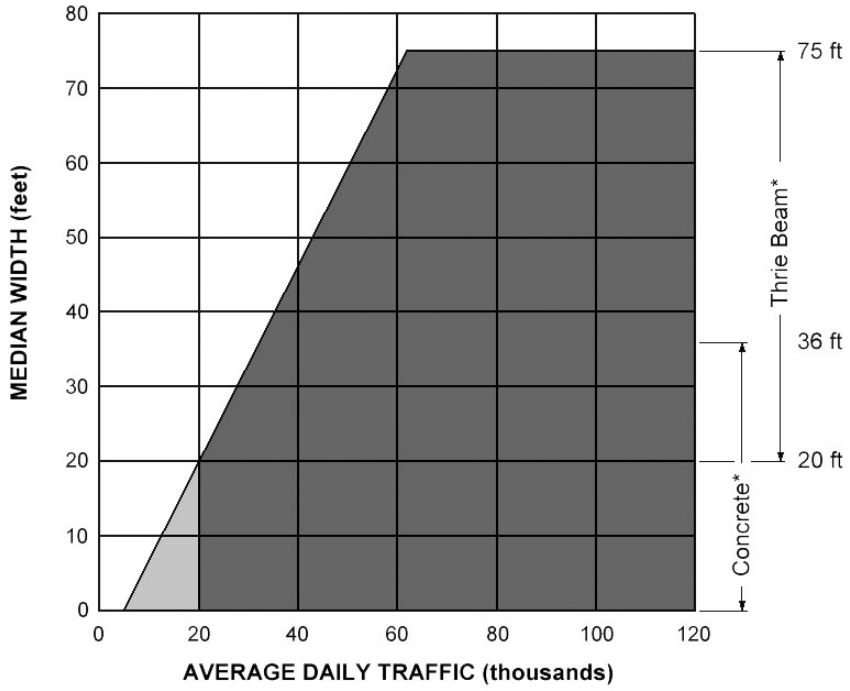
Temporary median barriers should be considered for narrow construction zone detours with large traffic volumes. Temporary Railing (Type K) is the appropriate barrier for most situations, although other temporary barriers are available and should be considered where appropriate. Temporary Railing may also be used for falsework protection and as a roadside barrier to protect construction sites.

2. *Non-freeways*. Median barriers can be an appropriate solution to cross-median accidents on multi-lane (two or more lanes in each direction) expressways and multi-lane conventional highways. The volume/median width warrant applies to freeways only, but they may be used as a guide for non-freeways.

When installing median barrier on non-freeways, a problem is created at each intersection opening in the barrier. The two ends of the barrier in this situation require special treatment. Careful consideration of the number of intersections, accident history, alignment, driveways, grade, and sight distance as well as traffic volumes and median width must be given for non-freeway installations. It is the engineer's responsibility to determine, decide, and document the best improvements.

Figure 7-7

FREEWAY MEDIAN BARRIER STUDY WARRANTS



Barriers in these cases should be considered only if there is an unusually high number or rate of cross-median accidents.

Study Warranted.

*For additional guidance on barrier type, see Section 7-04.4.

7-04.4 Criteria for Choice of Type

Each barrier system exhibits characteristics that make a given type of barrier more desirable in one location than another type of barrier. These characteristics are:

1. *Concrete Barrier*. This rigid barrier does not deflect upon impact, but dissipates impact energy within the vehicle suspension system at shallow angle impacts and by displacement of vehicle sheet metal at severe impact angles. The severity of impact can be greater with concrete than with thrie beam barriers at high impact angles. Impact angles tend to be larger with wider medians. This barrier requires little maintenance; consequently, traffic is not disrupted by extensive maintenance operations, and maintenance workers are not exposed to large volumes of relatively high-speed traffic. Concrete barrier is believed to have the highest percentage of unreported "accidents" since, in flat angle collisions with this barrier, most vehicles are redirected with minimal damage and are able to drive away. Finally, this is the cleanest barrier, with no projections to collect debris.
2. *Thrie Beam Barrier*. This barrier may deflect up to 2 feet on impact and provide some dissipation of energy through the displacement of posts and flattening of rail elements. Maintenance costs are higher than concrete barrier. Thrie beam barrier can sustain minor impacts without requiring immediate and extensive restoration work. This barrier system occupies more median than concrete barrier.

After the decision to use permanent median barriers has been made, the following guidance shall be used to determine whether concrete or thrie beam barrier is appropriate at a given location. (Note: All median barrier offset dimensions are measured from the edge of traveled way to face of barrier.)

If there is widening or other type of work that will reposition barriers in five years or less, consider an interim barrier such as Temporary Railing (Type K). This applies to all median widths with or without plantings. The interim barrier (type and offset distance) shall be approved by the Department's Headquarters (HQ) Division of Traffic Operations liaison. The project which repositions the barrier shall include the cost of installing the permanent median barrier.

	Median Width	**Equal to and Less than 36 feet (ft)**	**>36 ft to <46 ft**	**Equal to 46 ft**	**Greater than 46 ft**
NO PLANTINGS	**Barrier Type**	Type 60 concrete[1]	Consult HQ traffic liaison	Type 60 concrete or thrie beam	Thrie beam
	Placement	On centerline[2] pave up to face of barrier	Consult HQ traffic liaison	Offset 14 ft and pave up to it or on centerline (no median paving), respectively	On centerline
PLANTINGS	**Barrier Type**	Type 60 concrete[1]	Thrie beam	Thrie beam	Thrie beam
	Placement	On each side of planting, pave up to barrier, maximum offset 17 ft	On each side of plantings, minimum offset 16 ft	On each side of plantings, minimum offset 16 ft	On each side of plantings, minimum offset 16 ft

[1] Consult with headquarters Division of Traffic Operations liaison and headquarter Division of Maintenance liaison for using thrie beam

[2] Except when offset for barrier openings

In all cases where thrie beam barriers are used, a minimum distance of 16 -18 ft between face of rail and the edge of travel way must be provided for maintenance activities.

For median widths equal to and less than 36 ft, concrete barriers are the preferred barrier type. However, thrie beam barriers may be installed in medians where there is a history of an accumulation of sand in the median due to high wind, or in designated Federal Emergency Management Agency floodplain areas. Written concurrence for installing thrie beam barrier must be obtained from the Department's Headquarters Division of Traffic Operations liaison and Headquarters Division of Maintenance liaison.

Any exception to this policy shall be concurred by the Department's Headquarters Division of Traffic Operations liaison and both Deputy District Directors for Maintenance and Traffic Operations within appropriate district, and approved by the Headquarters Division Chiefs of Maintenance and Traffic Operations, or their designee.

7-04.5 Barrier Design Details

Construction details for concrete and thrie beam barriers are shown in the Standard Plans. Concrete barrier Type 50 series has "Jersey-style" sides and was the standard concrete barrier for many years. Concrete barrier Type 60 series, the current standard, has a single-sloped design on the sides. The width of the base is generally 24 inches. The standard height of Type 60 barrier is 36 inches. If glare screen is required, the 56-inch tall Type 60G concrete barrier should be used. The Type 60S concrete barrier is 32 inches tall and may be used where stopping sight distance would be impaired if the standard Type 60 barrier were used. The basic concrete barrier is normally constructed by slipforming without a footing on pavement. Ends of the barrier at gaps or contraction joints where the concrete and reinforcement is not continuous require a 10-inch deep by 10-foot long footing under the end of the barrier. This is intended to prevent displacement of the barrier in an impact at the discontinuity. Other versions of concrete barrier usually require fixed forms for construction.

Thrie beam barrier is made up of a 12 gauge triple corrugated galvanized steel beam nominally 20 inches wide by 3¼-inch deep mounted on wood or galvanized steel posts and wood blocks or plastic blocks. The top of the rail element is 32 inches above the surface at the face of the barrier. The rail is blocked out from the post with a wood block or plastic block. Wood line posts are 6 inches x 8 inches x 6 feet with the 8-inch dimension perpendicular to the rail element. All wood posts and wood blockouts must be treated to resist decay. The steel line post is a galvanized W6 x 9 hot rolled wide flange post 6½ feet long. The ends of thrie beam barrier must be anchored to ensure expected performance.

Where larger posts are required in transitions approaching fixed objects or transitions to concrete barrier railings, the wood posts are 10 inches x 10 inches with 8-inch x 8-inch wood blockouts, steel posts are W6 x 9 section and the wood blockouts are 6 inches x 6 inches.

Where a double-faced thrie beam barrier is proposed and a saw-toothed median section requires the rail elements to be mounted at different elevations, steel posts should be used. Thrie beam requires two mounting bolts that pass through the blockouts and post. For normal installations, the two parallel holes are drilled in a jig at the manufacturing plant. Field drilling a second pair of holes parallel to each other and the original pair is quite difficult and should not be done. Furthermore, the added holes in the line of the grain create a weakened plane in the post that can affect the barrier's performance.

Pavement rehabilitation projects placing thick layers of new paving can compromise the performance of existing median barriers. Normally, Type 50 concrete barrier can tolerate the addition of 3 inches of added pavement against its base without remedial measures being required. This reduces the effective height of this barrier to 29 inches. Where thicker pavement overlays are planned, either replace with new rail or taper pavement to maintain effective height of barrier.

Isolated freestanding ends of median barriers are substantial fixed objects. Hence, they must be protected from impacts by approaching traffic. This may be done by flaring the end of the barrier away from approaching traffic or placing an appropriate crash cushion at the approach end of the barrier. Sloping ends or ends that are turned down into the ground are not acceptable.

The total cost of barrier installation can vary considerably from project to project depending on the amount and type of site preparation required.

7-04.6 Median Design Considerations

Many of the difficulties encountered with irregular medians or continuous obstruction in the median can be avoided by the following considerations:

1. *Longitudinal Median Dikes*. When required, the dike should be as close to the thrie beam barrier as possible. When placed in front of thrie beam barrier, dikes should be 4 inches high or less. The dike should not be placed between 1 and 13 feet in front of the barrier. Dikes over 4 inches high shall not be placed directly under the barrier. Dikes shall not be placed in front of concrete barriers.
2. *Median Ditches.* Drainage ditches should be as shallow and as flat as possible. Where deep ditches are unavoidable, a barrier may be needed on both sides of the ditch.
3. *Median Drainage*. Thrie beam barrier is adaptable to most median drainage conditions. Concrete median barrier, however, may require special designs to provide drainage. Slotted drain inlets are the recommended means of providing drainage in paved medians with concrete median barrier. Design details for these are contained in the Standard Plans. Where a concrete barrier must span or cross an existing drainage inlet, special barrier gap closure details are available. Passing runoff under a concrete median barrier with scuppers on an all-paved cross section is not desirable. What was sheet flow becomes concentrated into streams across the lower roadway. Scuppers, if used, should not extend higher than 3 inches at the base of the barrier. Also, each scupper should be no more than 3 feet long and a series of scuppers should not occupy more than 25 percent of any 20-foot length of concrete barrier. Where a highway requiring median barrier is located in a flood plain and it is necessary to allow floodwaters to pass over the highway, thrie beam barrier should be used. For an additional discussion of median drainage, see Section 834.2, Median Drainage, of the Highway Design Manual.
4. *Raised Medians*. Barrier height should be measured from the median surface. Median barriers should not be placed on raised medians.
5. *Flat Medians*. On paved flat medians, the barrier height should be measured from the paved surface exclusive of any localized ditch surface. Medians adjacent to concrete barriers should be paved.
6. *Planted Medians*. Where plants are located in the median, and the plantings cannot be removed, two single barriers, one on each side of the plants, should be placed. See Section 7-04.4, Criteria for Choice of Type, to determine if the use of concrete or thrie beam barrier is appropriate. Earth berms used with median plantings should be eliminated.
7. *Maintenance*. Care must be taken that median maintenance or construction work done after a median barrier is in place does not change the effective height of the barrier.
8. *Future Construction*. Where traffic lanes are to be added to the median within five years of barrier construction, the median grade line should be adjusted and the barrier installed for the ultimate condition. If it is not practical to do this, concrete barrier should not be used since, unlike the other barrier types, the height of concrete cannot be readily adjusted.
9. *Median Cross-Slope*. Where median cross-slopes are greater than 10:1, vehicle trajectory can affect barrier performance. Using the procedures outlined in Traffic Bulletin No. 15, the relationship between median and traveled way cross-slopes should be checked to ensure desired barrier performance.

10. *Adding Lanes in the Median*. Where lanes are added in the median reducing the width of the median, the median barrier type to be used should be selected in accordance with Section 7-04.4, Criteria for Choice of Type. In some cases it will be necessary to remove existing non-concrete barrier and replace it with concrete barrier. Costs associated with the change in barrier type should be included in the preliminary scoping document estimate.

7-04.7 Emergency Passageways/CHP Enforcement Area

Except for emergency passageways/CHP enforcement area in median barriers, median openings are not allowed on freeways. The use of passageways shall be kept to a minimum and carefully located to provide good stopping sight distance to and from the opening along the freeway. Emergency passageways may be appropriate for highway patrol vehicles, emergency service vehicles such as tow trucks, ambulances, fire fighting apparatus and maintenance equipment. The need for such openings and their locations shall be established by the District in cooperation with the local Department of Highway Patrol office, fire district and emergency services. Emergency openings in glare screens for limited passage of stretchers or personnel are covered in Section 7-04.8.

Where emergency openings are provided, they shall be designed based on the following considerations:

1. *Types of Vehicles*. Passageways are designed for motorcycles or for motor vehicles. Motorcycle openings are 6 feet to 8 feet long, and openings for motor vehicles are 12 feet to 16 feet long.
2. *Types of Passageways*. Permanent openings and temporary openings with removable sections of barrier are the two types of passageways used. Permanent openings for motorcycle passage only may be provided in concrete and thrie beam barriers. Passageways for motor vehicles shall be by use of temporary, removable sections of barrier or permanent openings where the barrier ends are offset away from approaching traffic. All temporary openings shall be closed immediately after use.
3. *Spacing of Passageways*. By a combination of interchange ramps and passageways, provisions for access to the opposite side of the freeway may be provided. Access shall not be more frequent than at 3-mile intervals.
4. *Median Widths*. The median must be wide enough to accommodate turning vehicles safely, and contain the barrier with any necessary flares. Therefore, motorcycle passageways should not be provided where the median is less than 22 feet wide. Motor vehicle passageways should not be provided where the median is 32 feet or less in width, unless there are unusual circumstances.
5. *Barrier Design Details*. Designs for barrier passageways are shown in Barrier Passageways in the Standard Plans.
6. *CHP Enforcement Area*. For CHP enforcement area design details, please refer to the HOV Guidelines.

7-04.8 Glare Screens

1. *General*. Glare screens are designed to screen out the headlight glare of opposing traffic. Glare screen may be considered on new or existing median barriers where the median is 20 feet or less in width except on horizontal curves where glare screen would reduce sight distance to less than the stopping distance for the design speed. Glare screen should not be installed in medians wider than 20 feet.

   Glare screen should be installed where engineering evaluations show that the glare screen would be of overall benefit to the motorist considering the cost and other impacts of the glare screen. An engineering evaluation is required for all projects involving construction within the median for medians 20 feet wide or less. Engineering evaluations should consider glare due to the combined effects of grades, horizontal alignment, and traffic volumes. Public complaints are considered in the evaluation. On route segments with scenic views, the sensitivity of the public to the blocking of

these views should be considered. The engineering evaluation shall be incorporated in the appropriate project development report as specified in the Project Development Procedures Manual.

Based on engineering evaluations, glare screens may be installed on segments or spot locations along frontage roads or at entrance and exit ramps. Chain link fence with slats may be appropriate in these situations.

1. *Thrie Beam Barrier*. Glare screen is not generally used with thrie beam barrier.
2. *Concrete Barrier*. When glare screen is determined appropriate, the standard permanent glare screen for this barrier is concrete glare screen.
3. *Plantings*. Where plantings exist in the median, glare screen may be considered on structures with decked medians. When plantings are not in place but are planned, decked medians may include provisions to accommodate glare screen in the future.
4. *Emergency Openings*. When glare screen is included with the barrier, openings may be provided at approximately 600-foot intervals if requested by the California Highway Patrol. In areas with above average traffic collision rates, openings may be spaced at 300-foot intervals. Spacing may be varied to provide such an opening at each structure crossing over the highway.

7-04.9 Delineation

Commercial retroreflector units are available where it is necessary to provide enhanced delineation along median barriers. Reflective delineation along thrie beam barriers is provided by installing approved retroreflective units on top of the posts. Retroreflective delineation for concrete barriers is obtained by securing approved units to the top of the barrier. For further details regarding delineation for median barriers, please refer to the California MUTCD.

Section 7-05 -- Crash Cushions

7-05.1 Purpose

Crash cushions, also known as impact energy attenuators, are intended to protect a motorist from the consequences of a collision with a fixed object that cannot be removed or where other protective systems are not suitable. A prime example occurs at gores on elevated structures. Here the intersecting structure railings, often with a vertical pier or sign support, create a fixed object.

7-05.2 Available Crash Cushion Types

Types currently available include arrays of sand-filled plastic drums and several mechanical systems relying on a crushable medium and metal deformation, or a compressible hydraulic cylinder to dissipate impact energy. Information about designs and types of crash cushions currently approved for use on California State highways is available from your District Traffic Safety Devices Coordinator, your Headquarters Traffic Operations Liaison or Headquarters' Office of Traffic Safety Program.

7-05.3 Placement

Crash cushions should be installed at fixed objects that cannot be economically removed or made breakaway. They should also be installed to shield fixed objects where guardrail is inappropriate.